Proposed Sampling Program to Determine Extent of World Trade Center Impacts to the Indoor Environment

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BACKGROUND: This proposal is the result of ongoing efforts to monitor the current environmental conditions for residents and workers impacted by the collapse of the World Trade Center (WTC) towers. In March 2004, EPA convened an expert technical review panel to guide and assist the Agency in its use of available exposure and health surveillance databases and registries to characterize any remaining exposures and risks, identify unmet public health needs, and recommend any steps to further minimize the risks associated with the aftermath of the WTC attack.

The WTC Expert Technical Review Panel has met periodically in open meetings to interact with EPA and the public on plans to monitor for the presence of WTC dust in indoor environments and to suggest additional evaluations that could be undertaken by EPA and others to evaluate the dispersion of the plume and the geographic extent of environmental impact from the collapse of the WTC towers.

The panel was charged, in part, with reviewing data from post-cleaning verification sampling to be done by EPA in the residential areas included in EPA's 2002 Indoor Air Residential Assistance Program and to verify that recontamination has not occurred from central heating and air conditioning systems. With the assistance of Westat, a contractor in the field of statistics, EPA developed a sampling plan to evaluate whether apartments previously cleaned in EPA’s Region 2 clean and test program had become recontaminated. The EPA proposed plan was debated by the panel, and most panel members believed that an alternate study to test for “contamination” rather than "recontamination" should be conducted instead.

Using a peer review contract, EPA solicited comment from non-panel experts on the use of asbestos as a surrogate for determining risk from other contaminants and provided a report on those comments back to the panel. The non-panel experts generally supported the use of asbestos as a surrogate, but encouraged the concurrent testing for lead. Many individual members of the panel, however, did not support the position that asbestos was an appropriate surrogate in determining risk for other contaminants.

Subsequent discussions led to the concept that a WTC signature exists in dust and that sampling could focus on determining the presence of that signature, as well as the levels of contaminants of potential concern as a basis for determining the extent of WTC collapse contamination in indoor environments. The initial thought was that a signature could be developed for both the dust generated by the collapse and particulate matter generated by the fires which burned into December of 2001. However, it now appears that it will only be feasible to develop a signature for the collapse.

This draft final plan describes the approach to be used to evaluate the presence and levels of contaminants of potential concern in buildings in lower Manhattan and Brooklyn, including contaminants that could be markers for WTC building collapse dust. This plan is a modification of an earlier version announced in the Federal Register in October 2004. This draft final plan reflects appropriate elements from the comments received from the public, the individual members of the WTC expert technical review panel and subsequent discussion and review by EPA staff. A primary objective of this study will be to determine the geographic extent of WTC building collapse dust, and plans call for sampling beyond Canal Street to as far north as Houston Street in lower Manhattan, as well as into Brooklyn.

OBJECTIVES: Concurrent efforts have the following objectives **–**

(1) To estimate the geographic extent of WTC contaminants of potential concern (COPC) resulting from the building collapse plume by sampling residential and non-residential buildings in lower Manhattan and a portion of Brooklyn that agree to participate, and to provide a cleanup when appropriate.

(2) To relate results of the sampling to building cleaning history, construction, and to the role of central heating, ventilation, and air conditioning (HVAC) if the information collected will support such an analysis;

(3) To provide the data necessary to determine if a Phase II sampling should proceed, which will test for the presence of collapse residues in areas beyond the boundaries of the areas currently tested, and to provide the data necessary to determine whether and what further actions are warranted; and

(4) To validate a screening method to identify WTC dust.

APPROACH:

I. GEOGRAPHIC EXTENT

A. Overview: A primary objective of this sampling program will be to estimate the geographic extent of WTC collapse residues in a sample of buildings that agree to participate. Success in meeting this objective is contingent on developing a "signature" for WTC dust residue and the availability of a representative sample of buildings to provide sufficient coverage of the area to be studied**.** If a sufficient number of buildings do not agree to participate when selected, it may not be possible to satisfactorily estimate the extent of contamination with an adequate degree of confidence**.** An additional sampling objective is to attempt to ascertain the relationship between measurements and building cleaning history, construction, and the role of

HVACs in the potential recirculation of WTC dust. Based on an evaluation of the results, EPA will determine if a second phase of sampling should be extended into other areas. EPA will also clean up building units and buildings found to have contamination above specified benchmarks in association with WTC dust; and the results will provide a basis for a decision regarding the need for more extensive cleanup in areas determined to be affected by the collapse. The intent is to characterize entire buildings by sampling a number of units within each building selected. The area of sampling extends throughout lower Manhattan to Houston and Clinton Streets, and across the East River into a portion of Brooklyn. This area is more than double the size of the area included in the initial dust cleanup program conducted in 2002.

The “target population” from which the sample will be drawn is described below. For purposes of the objectives stated above, these buildings can also be characterized with regard to potential exposures – whether they are residential or non-residential, and non-residential mostly denotes buildings that house commercial or workplace environments. Some buildings may have both residential and non-residential spaces. A list of all buildings in the study area has been compiled. A statistical probability survey design will be used to identify buildings to sample, and then the participation of these buildings will be sought. Statistical procedures will be used to select alternate buildings if any initially selected building is unwilling to participate. Complete participation of each building included in this survey is required, meaning that at least one unit on every other floor within these buildings must be made available for sampling. Only with this level of participation can the survey be characterized as a “building survey.” As discussed below, a procedure to sample numerous “units” within the building will allow for an adequate building characterization.

B. <u>Sampling Design</u>: A probability survey design methodology referred to as spatially balanced sampling (Stevens and Olsen 2004) will be used to select a sample of buildings from the list of all eligible buildings. Spatially balanced sampling was developed as a powerful and flexible technique for selecting spatially well-distributed probability samples with wide application to sampling of environmental populations. The spatially balanced sampling methodology has been applied successfully to the sampling of lakes, rivers and streams and other environmental sampling applications in which selection of a probability sample that provides balanced coverage over a specified geographic area is required.

The buildings to be sampled in lower Manhattan and a portion of Brooklyn bordering the East River constitute a finite population of distinct units that occupy fixed locations specified by two-dimensional coordinates. The geographic coordinates for each building are key to the sample selection process. For the selection of buildings in this survey, two stratification variables were used: presence in an “EPIC” zone (these zones were developed by EPA’s Environmental Photographic Interpretation Center, see figure 2), and whether or not the building was breached by the collapse of the towers. These stratification variables are described below.

In order to complete the spatially balanced selection of buildings for the sampling area, the following will be accomplished:

(1) Identify the geographic area for sampling: Figure 1 shows the area that is included in this survey. It is bounded on the north by Houston Street, on the east by Clinton Street and it extends into Brooklyn. Figure 2 displays this area on a color-coded map.

(2) Identify buildings eligible for sampling: A complete list of all buildings in the sampling area has been developed. This list was developed by matching building footprint information provided by the NYC Department of Information Technology and Telecommunications with address, age and usage information obtained from the NYC Department of Housing Preservation and Development. Table 1 provides summary statistics for all buildings in all strata from the survey (see next section for strata definitions). Table 2 describes all the elements in this building database, and Table 3 provides building classifications for this database.

(3) Assign each building to a stratum: Once buildings eligible for sampling are identified, they must be assigned to a stratum. First, stratification variables must be defined. Two stratification variables were developed for this study. One is whether or not the building was “breached” by the collapse of the WTC towers. A survey of lower Manhattan buildings was performed by the NYC Department of Buildings shortly after 9/11. Buildings with structural damage, or whose glass was not intact were considered to be breached. Buildings with intact glass and buildings not inspected beyond the survey area were classified as not breached. Therefore, every building in the data base was described as either “breached” or “not breached”. The second stratification variable used is known as “EPIC” zones. These zones were developed by EPA’s Environmental Photographic Interpretation Center (EPIC, 2004). By examining satellite photography and other evidence, this organization determined the extent of deposition of WTC dust and debris. The ground dust/debris boundaries shown in Figure 2 were derived from the analysis of multiple images taken between September 11 and September 13, 2001. As can be seen in Figure 2, “confirmed dust/debris” areas extend to approximately Chambers Street, “probable dust/debris” areas extend to approximately Canal Street, and “possible dust/debris” areas extend to approximately Spring Street on the West side near the Holland Tunnel. The “confirmed dust/debris” area is the area that EPA believes was most heavily impacted by the dust generated when the towers collapsed. For purposes of this study, the categories of “probable” and “possible” were combined into one category. A third category of “no visible impact” includes all areas within the study area that were neither “confirmed” or “probable/possible” for visible dust. A fourth category includes all buildings in the Brooklyn portion of the study area. These stratification variables are the basis for defining five strata: confirmed-breached, confirmed-not-breached, probable/possible, no visible impact, and Brooklyn.

(4) Determine sample design to be used: Stevens and Olsen (2004) describe the methodology for selecting a spatially-balanced sample. Conceptually, the process guarantees that every sample that is selected exhibits a spatial distribution similar to that of the entire set of buildings in the study. For example, for the stratified design of this sampling program, the spatially-balanced property guarantees that the buildings selected within a stratum have a similar spatial distribution to that of all buildings within the stratum. In general, a sample that is

spatially balanced is likely to be more "representative" of the population of buildings than a simple random sample. This is due to the fact that a simple random sample of buildings in an area may result in a sample that does not include some subsets of the overall area because simple random sampling may result in sample buildings "clumping" in certain areas.

(5) Construct a list frame: A list of all buildings in the study area is constructed. This is referred to as the "frame." In addition to a unique building identifier, the list includes x- and y-geographic coordinates of the building centroids and a stratum value for each building (confirmed-breached, confirmed-not-breached, probable/possible, no visible impact, or Brooklyn.) To be compatible with software used to select spatially balanced samples, the frame is defined as a Geographical Information Systems shapefile.

(6) Determine sample sizes: The stratified spatially-balanced design includes five strata, as noted above. A sample size of 30 spatially balanced buildings will be selected within each stratum. This results in a total sample size of 150 spatially balanced buildings. The number of units within buildings that will be selected cannot be ascertained until the actual buildings to be sampled are selected. Given the multitude of buildings within the stratum and the desire for timely implementation of this sampling plan, EPA believes that sampling data generated from 30 spatially balanced buildings per stratum will allow for a reasonable estimation of the geographic extent of WTC COPC resulting from the building collapse plume and determination of what further actions may be warranted. Short of sampling a much larger portion of the almost 7,000 buildings across the five strata, EPA acknowledges that these determinations cannot be made with certainty but it is critically important to begin generating and evaluating data as soon as possible and in a manageable manner. In the event that sampling at 30 buildings in a stratum is not possible, decisions will be required as to whether to proceed with sampling and how the results might be used.

EPA further believes that achieving access to sample fewer than 20 spatially balanced buildings per stratum would be insufficient for allowing reasonable determinations as described above. In the absence of access to a sufficient number of buildings to determine the extent of contamination, EPA will offer a test, and clean if necessary, program targeted at the area south and west of Canal, Allen and Pike Streets, river to river. This is the area covered by EPA's previous indoor dust cleanup program. The results from sampling in this program will be considered by EPA, along with previously collected ambient monitoring data, modeling results, and EPA's own analysis of the sampling results, to make recommendations about expansion of the sampling areas or more general cleanup activities. Source attribution will also be considered as described below. The same decision criteria for activities following sampling with a validated method to identify WTC dust in indoor dust samples will be used.

(7) Select sample for design: The psurvey.design library for the R Statistical software is used to select a sample of buildings for the design. The spatially-balanced sample selection procedure of Stevens and Olsen (2004) is based on the shapefile list frame and the specified design, and is implemented using the psurvey.design library for the R Statistical software (R and the library are available free of charge at http://cran.us.r-project.org/). The sample selection

creates an ordered list of buildings that are assigned a unique sample identification number (siteID) for each building in the sample. This siteID will be critical during the implementation of the design, especially since buildings selected may not be available for sampling due to the building owner not agreeing to participate in the study. Figure 3 shows an example sample selection for a spatially-balanced random sample of the study area.

(8) Replacement of buildings: Buildings selected in the sample must be evaluated to determine if they are willing to participate in the study. We anticipate that some buildings will not participate and that in order to maintain the desired sample size, replacement buildings will be needed. The spatially-balanced survey design will address this by selecting an over-sample of buildings that can be used as replacements. This is a standard statistical procedure to compensate for non-response in surveys. These buildings are identified as oversample sites and included in the sample selection process order to maintain the spatial balance of the sample.

(9) Selection of units: Units on alternating floors will be selected. These units should be facing the World Trade Center site, and/or units served by a HVAC. The intent behind this procedure is twofold: to identify and sample the units most likely to have been impacted by the collapse plume, and to sample enough units within the building so as to be able to adequately characterize the building as a whole. Units facing the WTC site are those which are the most likely to have become contaminated based on their orientation with respect to the collapse plume as might be units with air supplied through a similarly impacted HVAC which serves their units. There may be reason to deviate from this procedure to, for example, sample only one unit in a single story building.

C. Approach to Building Characterization: All buildings in the sample evaluated for use will have a number of characteristics recorded. A major use for the information is to evaluate whether differences exist between buildings that agree to be sampled and buildings that do not. If differences do exist, additional statistical analyses may be completed to adjust for the differences. Building characteristics that may be relevant are described below. This section provides an overview of the strategy to characterize units within buildings, the whole building, and HVACs within buildings, if present. The Quality Assurance Project Plan (QAPP) describes in detail the protocol for selecting units within buildings to sample, how to determine where and how much to sample within units, and how to sample HVACs.

In order to gain sufficient coverage of each building, an appropriate number of samples will be collected based on the square footage on each floor, and the number of floors in the building. Therefore, it is possible that taller buildings or buildings with a large footprint may receive more representation in the results in terms of numbers of samples. Adjustments may be required to account for location so that buildings with more data do not misrepresent spatial patterns.

A “unit” generally denotes a reasonably well defined section of a floor that will be different for each building and building type. For example, a unit within a school could be a classroom, within a residential building could be an apartment, and within an office building could be an area including cubicles and private offices. Priority in unit selection will be given to the units closest to Ground Zero (i.e., the ones most nearly facing Ground Zero) and/or served by a HVAC.

Three sets of dust samples will be taken within each unit: 1) three or more samples at locations where dust-related exposures are likely to occur, such as in elevated horizontal surfaces (e.g., desk or table tops) and floors, 2) three or more samples at locations where WTC dust may have accumulated but has not frequently been cleaned, such as on top of cabinets and 3) a single composite sample from “inaccessible” locations where cleaning is unlikely. The first set of samples will be termed, “accessible” samples and the second, “infrequently accessed” samples, the third “inaccessible” samples. Samples from the first two locations will be taken by wipes and microvacs. These samples will yield results in load (weight or fibers per unit area) and will be compared to benchmarks.

The sample from the third set of locations (“inaccessible”) will be bulk dust samples or collected by HEPA vacuums and will yield results in concentration (weight or fibers of contaminant per weight of sample). The location of many of the inaccessible areas does not lend themselves to obtaining load samples (mass per unit area) that could be related to the benchmarks. Concentration (weight per weight) of a contaminant in settled dust is a poor indicator of risk. An environment with little dust would not pose a risk even if there was a high concentration of the contaminant in the small amount of dust. Therefore, the “inaccessible” area sample results will be used for signature screening and considered with modeling and monitoring results in determining the geographic extent of the distribution of dust from the WTC collapse. “Inaccessible” area sample results will not trigger a cleaning.

Wipe samples will be analyzed for the COPC lead and polycyclic aromatic hydrocarbons (PAHs), microvac samples will be analyzed for the COPC asbestos and man-made vitreous fibers (MMVFs); and bulk dust and HEPA vacuum samples will be analyzed for the COPC and to screen for the presence of WTC dust. Wipe and microvac samples will be taken in proximate locations, so that for each location sampled within a unit, there will be measurements of the four COPC. When necessary, air samples will be collected in common areas and analyzed for COPC as described below. Further detail on the strategy for unit selection and then selection of locations within units to sample are provided in the Quality Assurance Project Plan.

The analytical results from these samples will be used to determine whether or not a cleaning will be offered to the occupant or owner of the unit being tested. Results from all units of a building will be used to determine whether a full building cleanup will be offered, and results from the study as a whole will be used to determine what further activities with regard to sampling or cleanup are warranted. Details on the criteria used to make these decisions are described in Section G below.

Specific building and space characteristics will be gathered in order to aid in understanding the results. The information will be gathered using preprinted checklists which will record:

<u>Descriptive information</u>
*Building age and type
*Location of floors sampled per bldg
Number of rooms sampled per floor
Square footage of floors and of space sampled per floor
*Location of space sampled on floor
Cleaning and renovation history since WTC collapse
*Type, number, age of windows in spaces sampled
*Number of window or wall HVAC units
Cleaning and replacement history of window or wall HVAC units since WTC collapse
*Visible WTC dust reported present in unit
Reported cleaning frequency and date of last cleaning prior to sampling
Carpet present
Carpet cleaned or replaced since WTC collapse

<u>Attribution Information</u>
Location and amount of friable asbestos material present in sampled space
Location and area of MMVF present, i.e. ceiling tiles, pipe insulation, spray on fireproofing
Location and amount of chalking/peeling paint present
Current use of space
Significant particulate or combustion sources within sampling area, e.g. fireplace, stove, occupant smokes
Significant particulate or combustion sources within or adjacent to the building, e.g. above fast food restaurant, adjacent to emergency diesel generator exhaust

<u>Central HVAC Design Information</u>
*Location of air inlets
Location of filters or other air cleaning devices in system
Number and Location of HVAC return ducts in sampled space
Central HVAC cleaning and replacement history since WTC collapse

The "*" variables will be considered in a secondary data analysis. We will determine the degree of correlation between exceedances and these variables.

D. <u>Contaminants of Potential Concern</u>:

COPC which will be measured in this program include asbestos, man-made vitreous fibers (MMVF), PAHs, and lead. A total of 6 COPC, including these four as well as silica and dioxin, were identified by EPA Region 2 during 2002. A full discussion of these 6 COPC can be found in *World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks* (EPA, 2003a; referred to as the COPC Report below). The COPC Report includes justifications for selecting these WTC-related contaminants as COPC, and also the basis for the health-based benchmarks for these contaminants in indoor air and settled dust. The COPC Report and the COPC benchmarks developed in it were peer reviewed. EPA's preferred approach to establishing cleanup benchmarks is risk-based. As the public and some members of the panel have expressed strong opinions against sampling for asbestos and MMVF in air, and inhalation is the pathway of concern for these COPC, the air concentration benchmarks in the COPC Report for these COPC are not appropriate for current purposes. The public and some members of the panel also expressed concern that an earlier EPA proposal to use three times a background dust concentration as a cleanup benchmark may not be sufficiently protective. Also, EPA believes it would be difficult to establish a statistically robust background data set to develop this three times background benchmark, due to the number and variety of buildings in the study area. For these reasons, EPA has had to develop new cleanup benchmarks for this study.

Since only dust will be measured in this program, of particular note is the establishment of risk-based benchmarks for dust for two of the COPC, PAHs and lead. These benchmark values, at 150 $\mu g/m^2$ for PAHs and 40 $\mu g/ft^2$ for lead, will be used in post-sampling decision making regarding cleanup activities (see section below on Decision Criteria). The PAH benchmark is health-based; it was developed as part of the earlier COPC effort (EPA, 2003a), and its value was supported in the peer review. The lead benchmark was developed by the United States Department of Housing and Urban Development (HUD). Health-based benchmark values for the other COPC were established for sampling in air, but not for dust, in the COPC Report.

It should be noted that the health-based benchmark for lead in settled dust in the COPC Report was based on the HUD screening level (25 $\mu g/ft^2$) for accessible floor space. The HUD screening value was consistent with the purpose of the wipe sampling performed in EPA's 2002 WTC Indoor Air Residential Assistance Program (i.e., to determine the efficiency of the cleaning techniques rather than as a action level for triggering a clean-up). The benchmarks developed for the WTC sampling program may serve as action levels for cleanup. As such, the health-based benchmark for lead should be consistent with the dust hazard/clearance standards in the HUD regulation. Therefore, the criteria established by HUD will be followed:

Floors = 40 $\mu g/ft^2$
Window Sills = 250 $\mu g/ft^2$
Window Troughs = 400 $\mu g/ft^2$

As noted earlier, individual members of the WTC Expert Technical Review Panel have recommended against the use of air sampling for detecting WTC related fibers (asbestos and MMVF) in the indoor environment as part of the sampling program. Individual panel members are of the opinion that settled dust provides a better medium for identifying the presence of residual fibers as well as offering a simpler and less intrusive sampling protocol. The absence of air sampling, however, creates a data interpretation void because unlike air, health-based benchmarks for asbestos and MMFV in settled dust were not included in the COPC report.

Earlier versions of this sampling plan discussed the capacity of asbestos and fibrous glass to re-entrain in indoor air, and the possibility of developing settled dust benchmarks based on an inhalation pathway. However, development of a "k" factor, which is an empirical factor relating a dust concentration to an air concentration, was not pursued for this sampling plan based on recommendations of individual members of the expert technical review panel, who cited the considerable uncertainty inherent in characterizing the relationship between fiber loads in indoor air and settled dust. Factors contributing to this uncertainty include surface porosity, activity patterns, fiber dimensions, room volume and air exchange rates.

In the absence of asbestos air sampling, and given the uncertainty associated with the modeling of air concentrations based on asbestos loads in settled dust, a weight-of-evidence approach has been developed for establishing a benchmark for asbestos in settled dust. The American Society for Testing and Materials (ASTM) has published an "Experience" Standard based on the work of Millette and Hays (1994) for interpreting asbestos loads (structures per unit area) in settled dust. The standard pertains to samples obtained by the microvac (ASTM 5755) sampling technique. According to this standard:

1,000 S/cm^2 = "Low" concentration
10,000 S/cm^2 = "Above Background" concentration
100,000 S/cm^2 = "High" concentration

[Note: This document references two types of fibrous materials, asbestos and man-made vitreous fibers (MMVF). These materials have alternately been described as fibers or structures in various citations in the literature. For the purposes herein, the term "structures" refers specifically to asbestos as analyzed by transmission electron microscopy (TEM), and is consistent with the counting procedures detailed in the Asbestos Hazard Emergency Response Act (AHERA). MMVF and asbestos analysis by phase contrast microscopy (PCM) are referred to as "fibers."]

The asbestos contamination in the town of Libby, Montana, offers additional information for consideration in the development of a benchmark for asbestos in settled dust. At that site, an action level of 5,000 S/cm^2 in generally accessible areas has been established for triggering a cleanup in a residential dwelling.

Finally, there has been discussion at the panel meetings relating to using a multiple of background for setting a benchmark for asbestos in settled dust. A factor of 3X had been proposed in the October 2004 draft WTC sampling plan. EPA's WTC Background Study (US EPA, 2003b) reported a mean value of approximately 2,250 S/cm^2 for residential dwellings sampled by the microvac method.

Based on the above discussion, a benchmark of 5,000 S/cm^2 is proposed for asbestos in settled dust. This value is the approximate midpoint in the ASTM Experience Standard that is bounded by values considered "low" and those considered "above background." It is consistent with the action level used for residential cleanups in Libby, Montana, and it represents a value that is approximately two to three times background as characterized in EPA's WTC Background Study.

A benchmark for MMVF in settled dust was developed with consideration given to both its toxicity and background levels relative to asbestos. In one respect, it would be intuitive to establish a value that is less stringent than the number (5,000 S/cm^2) developed for asbestos. This is based on the understanding that, on a fiber-for-fiber basis, asbestos is viewed as more hazardous than fibrous glass (a prototypical form of MMVF). This is reflected in the OSHA Permissible Exposure Limit (PEL) which is an order of magnitude more stringent for asbestos (0.1 f/cc vs. 1.0 f/cc - PCM) and the greater than order of magnitude difference in the WTC heath-based benchmarks established for asbestos (0.0009 S/cc - PCMe) and fibrous glass (0.01 f/cc). Conversely, the background levels of MMVF found in EPA's WTC Background Study are more than an order of magnitude lower than the levels reported for asbestos. However, there were fewer MMVF samples (compared to asbestos) obtained in the WTC Background Study lending greater uncertainty to the reported value. Also, unlike asbestos, there is little in the scientific literature relating to MMVF loads (fibers per unit area) in settled dust. Based on the discussion above, a case could be made for setting the MMVF benchmark in settled dust either considerably higher (based on toxicity) or lower (based on background) than the value established for asbestos. It is proposed that the value applied to asbestos, 5000 S/cm^2, also be applied to MMVF. This value was specifically developed for this program, is not risk based and is not intended for use in any other context.

Silica, Dioxin and Mercury: Silica and dioxin, selected as COPC by EPA Region 2 in 2002, are not included in this program. The COPC Report based the inclusion of dioxin as a COPC on the levels found in the ambient air in the weeks/months after September 11, 2001, when combustion processes were still taking place. At the time the COPC Report was finalized, limited preliminary data on dioxin wipe samples (approximately 200) in lower Manhattan residential dwellings were available. These data indicated a preponderance of non-detects. However, the aforementioned presence of dioxin at elevated concentrations in the ambient environment post 9/11 was sufficient basis for including dioxin as a COPC. Dioxin concentration in ambient air has since returned to background levels. In addition, the complete data set of over 1,500 dioxin wipe samples obtained from residential dwellings in lower Manhattan revealed only eight exceedances of the health-based benchmark of 2 ng TEQ/m^2 (TEQ is an acronym for Toxic Equivalents which is a cumulative measure of toxicity for a suite of dioxin and furan compounds that are dioxin-like). Given this evidence, additional sampling for dioxin is not included in this program.

Crystalline silica was included as a COPC based primarily on its relative abundance (on a percent weight basis) in bulk and settled dust samples taken in both outdoor and indoor locations during the fall of 2001. At that time, the amount of residual dust/debris in lower Manhattan was significant. The concern with the presence of crystalline silica in dust/debris relates to its ability to become airborne and ultimately inhaled. Sampling conducted in the fall of 2001 (ATSDR/NYCDOHMH, 2002) demonstrated measurable levels of crystalline silica in indoor air when high concentrations of crystalline silica were observed in settled dust (up to 31% by weight). However, the ATSDR/NYCDOHMH report concluded, "*Short-term exposure to quartz (crystalline silica) even for a continuous year of exposure at the highest estimated air* *concentration, is not expected to result in any adverse health effects. Assuming worst-case theoretical assumptions, the estimated quartz (crystalline silica) levels measured cannot rule out adverse health effects from chronic exposures (i.e., 30 years). For individuals who conduct frequent cleaning of their residences, as recommended in this report, or participate in the U.S. Environmental Protection Agency cleaning/sampling program, it is unlikely that their exposure would resemble these worst-case conditions."*

The significant reduction in residual dust/debris (and therefore crystalline silica) in both the outdoor (e.g., cleanup of Ground Zero) and indoor (e.g., EPA's 2002 WTC Indoor Air Residential Assistance Program) environment over the past three plus years would further reduce the potential for this mineral to pose a potential chronic health threat. Additionally, sampling for relatively low levels of crystalline silica is confounded by the fact that this mineral is a major component of the earth's crust (Casarett & Doull, 1996). This fact is evidenced in the following statement, from the COPC Report: *"Since quartz (crystalline silica) is a common material in sand, finding this mineral in a city where there is a great deal of concrete is not unusual."* Consequently, sampling for crystalline silica in settled dust is not included in this program.

Mercury has been the subject of much debate relating to its exposure potential post 9/11. Previously, there have been reports of elevated mercury levels in both biological and environmental samples. In the first case, medical monitoring of Port Authority officers assigned to the WTC site registered marginally elevated mercury blood levels in four officers. An investigation (NYCDDC, 2002) revealed no elevation in urine mercury levels in this group, nor could an environmental source be identified. It was determined that the officers were not dietary restricted for known sources of mercury (e.g., fish) prior to screening. Repeat sampling under controlled dietary conditions demonstrated blood mercury levels to be within normal limits. Additional evidence of negligible occupational exposure to mercury vapor during the WTC rescue /recovery operation is provided by a study in firefighters. Edelman, et al. (2003) reported only one elevated (>35 ug/gm creatinine) urine mercury level in 10,000 samples.

An environmental investigation by I.H. Consultants Inc. (Singh, 2002) in various indoor and outdoor locations in lower Manhattan identified mercury vapor levels orders of magnitude above urban background concentrations. This investigation was performed with a Jerome Meter which is a particularly poor instrument for measuring low-level airborne mercury. The mercury concentration in ambient air in urban environments is generally below 20 ng/m^3 (Johnson, 2002). The detection limit for the Jerome Meter is 3,000 ng/m^3. Many of the elevated levels, relative to background, detected in the Singh report (2002) were at or close to the detection limit of the Jerome Meter. A subsequent investigation by Johnson (2002) in the same locations sampled by Singh was performed using a Lumex RA-915 mercury vapor analyzer. The detection limit for this instrument is 2 ng/m^3 (1,500X more sensitive than the Jerome Meter). None of the elevated readings reported by Singh could be replicated with the Lumex. In over 100 individual samples, the highest concentration detected was 319 ng/m^3 , a reading that is an order of magnitude below the detection limit of the Jerome Meter. EPA's chronic reference concentration (RfC) for mercury vapor is 300 ng/m^3. Evaluation of these data along with additional data sources detailed in the COPC/Benchmarks Report (2003), including preliminary mercury wipe sampling results from EPA's 2002 WTC Indoor Residential Assistance Program, formed the basis for not including mercury as a WTC COPC. At the present time, the complete wipe sampling data set is available, and it contains over 1500 samples. Results show that there were only six exceedances of the benchmark of 157 $\mu g/m^2$ and the highest single value was 248 $\mu g/m^2$.

RJ Lee Inc.(2003/2004) has performed extensive environmental sampling in the former Deutsche Bank building at 130 Liberty Street. This building, now slated for deconstruction, was heavily impacted by the WTC disaster. Mercury was sampled in settled dust by wipes and in indoor air by a Lumex direct reading mercury vapor analyzer. Over 2,000 wipe samples were obtained. The maximum recorded value (600 $\mu g/m^2$) exceeded EPA's health-based benchmark for mercury (157 $\mu g/m^2$) by approximately a factor of four. However, the average mercury wipe sample was less than 20 ug/m^2, well below the health-based benchmark. RJ Lee Inc. computed 95% upper confidence limits (UCL, and defined on page 17) on the mercury wipe sampling on each of the building's 40 floors. None of the individual 95% UCLs by floor exceeded the health-based benchmark, indicating that area-wide mercury did not pose a significant exposure threat from contact with residual dust. The air sampling performed by RJ Lee Inc. only recorded significantly elevated levels of mercury in air under circumstances unlikely to be encountered in an occupied space, such as torch cutting of steel. All ambient air samples obtained in general office space were below EPA's chronic RfC for mercury.

Results of ongoing ambient, outdoor, mercury vapor monitoring at a site (4 Albany Street) adjacent to 130 Liberty Street has consistently demonstrated levels to be below EPA's RfC of 300 ng/m^3.

E. Analytical Methods and Sampling Protocols: These are shown in Table 4. Lead will be sampled with wipes, as the health-based benchmark for lead is based on a wipe sampling method (EPA, 2003a). PAHs will also be sampled by wipes. The health-based benchmark for PAHs was developed based on exposure and health-impact considerations and was not specific to a sampling method (EPA, 2003a). It is expected that wipe sampling will capture the PAHs that exist on dust particles and also PAHs that could be trapped on oily films that may be present on non-porous surfaces like table or countertops. As such, a wipe sampling approach for PAH measurement is expected to provide a conservative (i.e., as high as possible) estimate of the PAHs available for exposure. The remaining COPC, asbestos and MMVF, will be sampled using a microvac. The decision to use a vacuum approach for these COPC in contrast to a wipe method is for the purpose of comparison to an ASTM experience standard for asbestos. A HEPA vacuum will also be used by sampling teams in order to sample for the WTC dust screening components. The detailed protocols describing procedures to select units within buildings, procedures to identify locations within units to sample, procedures to sample using wipes, microvacs and HEPA vacuums and the analytical methods are all contained in the draft QAPP for this program.

F. Heating, Ventilation, and Air Conditioning (HVAC) Sampling: In order to characterize central HVAC units in buildings which have full or partial central HVAC units ("full" is defined as units serving both common areas and individual apartments, offices, etc;

while "partial" is defined as units serving only common areas while apartments or offices have individual units), samples will be taken in: 1) outdoor air inlets to HVAC; 2) air mixing plenums serving sampled floors; 3) HVAC outlets discharging to locations where COPC samples are taken; and 4) HVAC filters will be sampled. For the entire building HVAC system, four composite samples will be developed corresponding to these four areas – one composite of outdoor air inlet samples and so on. As is the case with the inaccessible areas these areas do not lend themselves to obtaining load samples (mass per unit area) that could be related to the benchmarks. Samples will be obtained using a HEPA vacuum or as bulk dust. Each composite will be analyzed for the signature components, as well as COPCs, on a concentration basis. Concentration (weight per weight) of a contaminant in settled dust is a poor indicator of risk. A location with little dust would not pose a risk even if there was a high concentration of the contaminant in the small amount of dust. Therefore, the COPC sampling results for HVACs will not be used to trigger a cleaning. However, in order to obtain more information about the potential role that HVACs have on air quality and the circulation of COPCs within buildings, whenever a decision to offer a whole building a cleanup is borderline and the HVAC contains the WTC signature, multiple air samples will be taken where HVAC outlets discharge into common areas of buildings (near the locations of the dust samples being taken as per the third category of HVAC dust samples noted above). These air samples will be analyzed for concentrations of the COPCs asbestos, MMVF, PAH and lead and the results compared to the air benchmarks in US EPA (2003a). The results will be evaluated with all other HVAC and full building results to determine appropriate additional activities associated with HVAC sampling or cleanup. The full protocol for HVAC sampling is provided in the draft QAPP.

G. Decision Criteria for Activities Following Sampling: The indoor sampling program outlined in this proposal will provide data that will be the basis for decision-making on whether to offer a cleaning to the unit being sampled, whether to offer a cleaning of the entire building being sampled, and whether to extend the area for sampling to determine the extent and magnitude of WTC dust presence. Additional sampling and/or cleaning activities within the study area might also be appropriate, but this section only outlines the process for these decision endpoints. A further examination of these data from the program by EPA with appropriate input may lead to other activities.

There are two sources of information that contribute to the decision-making process for an initial unit cleaning. These are the measurements of the COPC and the determination as to whether sampled dust contains WTC dust. As discussed below, efforts to identify screening materials used to identify whether WTC dust is present within a dust sample and to validate the method for use in this sampling program are underway. The candidate materials identified include slag wool, gypsum and elements of concrete.

Decision criteria are required for two possible scenarios: the method validation study for identifying WTC dust is successful, or it is not.

(1) The method validation study is fully successful in identifying screening materials that can identify WTC dust in indoor dust samples.

Figure 4 displays a decision tree for this evaluation (due to space limitation in this figure the ambient air sampling is not included in the decision tree). It is assumed that the signature screening method study is completed and has been successful in validating a method to identify WTC dust. The theme inherent throughout this figure is that, where COPC exceed benchmarks, a cleanup will be offered to the owner or occupants for those units or buildings sampled that have the COPC associated with dust from the WTC. For buildings, the decision will be based on an examination of all the data within the building related to the WTC collapse. For units, this translates to the following: if at least one COPC sample in a unit has an exceedance of a benchmark *and* if at least one sample taken for identification of WTC dust indicates the presence of WTC dust, then a cleanup is offered. The decision for HVAC cleanup is tied to a building cleanup decision: HVACs will be cleaned if the building criteria for cleanup is met, and the WTC signature can be found in the HVAC dust samples. Specific procedures for units, buildings and HVACs are described below.

<u>Approach for Unit Areas</u>: Typically EPA would base decisions on cleanup using health-based benchmarks for concentrations of COPC. For fibrous materials, such as asbestos, the peer-reviewed benchmarks are based on ambient air concentrations. In this sampling program, the method for determining concentrations of COPC will be by wiping or vacuuming surfaces for settled dust. This has been the preferred approach for many groups in the community affected and for many individual members of the expert technical review panel. In deference to this opinion, air sampling will not be conducted. The COPC report established health based benchmarks for asbestos and MMVF in indoor air but not in settled dust. The amount of research necessary to establish health-based benchmark concentrations in dust for the remaining decision-making COPC precludes pursuing their derivation if the sampling program is to proceed in a timely manner. Thus, health-based benchmarks will not be available for asbestos and MMVF. Instead “cleanup benchmarks” have been established for them. The derivation of these was described above in the COPC section; for asbestos the benchmark is 5,000 S/cm^2, where the count of structures included both long (> 5 µm) and short (0.5 – 5.0 µm) fibers, and for MMVF the benchmark is similarly 5000 f/cm^2. For PAHs and lead, the health-based benchmarks, 150 µg/m^2 for PAHs and 40 µg/ft^2 for lead based on wipe sampling methods, will be used as the appropriate benchmarks in this decision framework.

The WTC sampling program proposes to conduct settled dust sampling in both accessible (for current hazard assessment) and infrequently accessible (for potential contaminant reservoirs) areas. A potential hazard can occur from contaminant reservoirs in infrequently accessible areas through contamination/recontamination of accessible areas and/or direct contact with these reservoirs. In either case, the contaminant load in these areas would need to be significantly greater than the aforementioned benchmarks to pose a hazard, since they are infrequently accessed. Accordingly, separate benchmarks in settled dust for infrequently accessible areas have been established.

<u>Accessible areas</u>: As described above, benchmarks for COPC in settled dust have been established. Because these benchmarks are based on either the potential for direct contact for ingestion toxicants (lead and PAHs) or re-entrainment potential for inhalation toxicants (asbestos and MMVF), their application is specific to contaminant loads in accessible areas that are routinely contacted (e.g., floors, countertops, etc.). The benchmarks for accessible areas are listed below:

Lead	-	40 µg/ft^2
PAHs	-	150 µg/m^2
Asbestos	-	5,000 S/cm^2
MMVF	-	5,000 f/cm^2

Note: as per the HUD criteria described above a 250 µg/ft^2 benchmark will be used to evaluate window sill samples.

<u>Infrequently Accessed Areas</u>: The development of these benchmarks has taken into consideration recontamination potential and direct contact. In addition, relevant guidance/regulations were reviewed to inform benchmark development. Because infrequently accessible areas (e.g., out of reach shelving, etc.) are likely to represent a considerably smaller surface area and direct contact threat relative to accessible areas, a higher level benchmark is indicated. With respect to relevant guidance/regulations, HUD provides a model for setting a two-tiered benchmark. The friction associated with the movement of lead-painted windows creates reservoirs in the window troughs which can serve as a source of contamination to other areas as well as a significant, although infrequent, source of direct contact exposure. The HUD clearance standard for window troughs is 400 µg/ft^2, a factor of ten greater than the standard for floors (40 µg/ft^2). It is therefore proposed that the HUD clearance standard for window troughs serve as the benchmark for evaluating wipe samples obtained from infrequently accessed areas that may serve as recontamination reservoirs and/or sources of heightened direct exposure. Like lead, the benchmark (accessible areas) for PAHs in settled dust is health-based and driven by the potential for children to routinely contact accessible surfaces (e.g., floors, walls, tables, countertops, etc.). Similarly, a benchmark for infrequently accessed areas should reflect reduced direct exposure potential as well as a limited area source for potential recontamination of accessible areas. It is therefore proposed that the same order-of-magnitude factor in the HUD clearance standards for floors and window wells be applied to the PAH settled dust benchmark for infrequently accessed areas.

Benchmarks for asbestos and MMVF in settled dust for accessible areas were based in part on the ASTM "Experience Standard." The benchmark for asbestos (5,000 S/cm^2) was the approximate midpoint between the values ASTM established as "low" (<1,000 S/cm^2; i.e., unlikely to result in a significant re-entrainment potential) and "above background" (> 10,000 S/cm^2). The ASTM "Experience Standard" established a third value (>100,000 S/cm^2) equating to significant releases from source material. The benchmark for infrequently accessed areas for asbestos will be 50,000 S/cm^2. This is approximately the midpoint between the two ASTM standards of 10,000 ("above background") and 100,000 ("significant releases") and is consistent with the 10:1 ratio used above for PAHs and lead for the difference between the accessible and infrequently accessed benchmarks.

The MMVF benchmark for settled dust in accessible areas was set at the same level as asbestos. This was justified based on toxicity and concentration observations, as discussed above. A different approach was taken to assign a benchmark for MMVF for infrequently accessed areas; it is not based on the midrange between two ASTM standards, but rather on actual WTC dust measurements of MMVF. As described in the Signature Study section below, samples of WTC dust from both outside and inside locations taken near Ground Zero during September 2001 and also during 2004/2005 were measured for various types of MMVF, including slag wool, and they were found at high levels. Slag wool was the predominant MMVF, comprising about 80% of the total MMVF concentration. Slag wool concentrations (in fibers of slag wool per gram of dust, f/g) ranged from 113,000 to 13,400,000 f/g, with this high measurement from an outdoor sample taken by USGS near Ground Zero on September 16, 2001. The next highest sample was 11,800,000 f/g taken indoors at the Deutsche Bank in a sample taken during the fall of 2004. The next highly concentrated WTC dust sample contained 5,700,000 f/g of slag wool, also taken the Deutsche Bank in the latter part of 2004. Although heterogeneity in the concentration of slag wool in WTC dust may account for this drop-off in fiber concentration, a likely contributing factor is dilution with non-WTC dust. The average of the two high values listed above, 12,600,000 f/g, is utilized to represent undiluted WTC dust. USGS reports a density of WTC bulk dust to be 0.339 g/cc. Thus, there are 4,271,400 f/cc of slag wool (12,600,000 f/g * 0.339 g/cc) in 100 % WTC dust. Assigning a value of 1 millimeter as the thickness of a dust layer in an "infrequently accessed" area yields a fiber load of 427,140 f/cm^2 (4,271,400 f/cc * 0.1 cm). At a dilution of 10 % WTC dust in the sample, the slag wool load would be 42,714 f/cm^2 (427,140 f/cm^2 * 0.10). Based on USGS estimates that slag wool comprises about 80% of total WTC MMVF, the corresponding benchmark for MMVF would be 53,392 f/cm^2. Rounding down to the nearest ten-thousand yields a benchmark of 50,000 f/cm^2.

With this approach, an MMVF benchmark for infrequently accessed areas is based on actual WTC dust MMVF concentrations, coupled with a conservative assumption that as little as a 10% dilution in these areas would be sufficient to meet the criteria.

In summary, the following are the proposed benchmarks for infrequently accessed areas:

Lead	-	400 µg/ft^2
PAHs	-	1,500 µg/m^2
Asbestos	-	50,000 S/cm^2
MMVF	-	50,000 f/cm^2

<u>Inaccessible areas</u>: These areas include, for example, behind refrigerators and rarely moved furniture, tops of duct runs and other areas which are rarely cleaned and exposure potential is expected to be low. The location of many of the inaccessible areas does not lend themselves to obtaining load samples (mass per unit area) that could be related to the benchmarks. Concentration (weight per weight) of a contaminant in settled dust is a poor indicator of risk. An environment with little dust would not pose a risk even if there was a high concentration of the contaminant in the small amount of dust. Therefore, the COPC sampling results for inaccessible areas will not be used to trigger a cleaning. These areas are proposed to be HEPA vacuum sampled only for signature presence determination and COPC concentrations to help define plume extent.

Approach for Heating, Ventilation, and Air Conditioning (HVACs): HVACs are proposed to be sampled in the same manner as inaccessible areas and would only be cleaned if the signature is determined to be present in the HVAC system and a whole building cleaning is triggered based on the 95% UCL criteria (see decision tree Figure 4). However, in order to obtain more information about the potential role that HVACs have on air quality and the circulation of COPCs within buildings, whenever a decision to offer a whole building cleanup is borderline and the HVAC contains the WTC signature, multiple air samples will be taken where HVAC outlets discharge into common areas of buildings (near the locations of the dust samples being taken as per the 3rd category of HVAC dust samples noted above). These air samples will be analyzed for concentrations of the COPCs asbestos, MMVF, PAH, and lead and the results compared to the benchmarks in US EPA. (2003a). The results will be evaluated with all other HVAC and full building results and source attribution surveys, to determine appropriate additional activities associated with HVAC sampling or cleanup. The full protocol for HVAC sampling is provided in the draft QAPP

Approach for Buildings: The proposed decision criterion for a judgment relating to full building cleanup involves the use of a 95% Upper Confidence Limit (UCL) on a mean contaminant level. An Upper Confidence Limit (UCL) is a measure of uncertainty in an estimated mean due to sampling, measurement and other sources of variability in a set of data. The 95% UCL defines a value that will be exceeded by the true mean approximately 5% of the time in repeated sampling. The 95% UCL is commonly employed in EPA hazardous site assessments to provide a conservative upper bound estimate on the average site-wide contaminant level. The UCL will be used in the decision process as follows: If the 95% UCL for the estimated building mean exceeds the benchmark value for a COPC, and concurrently, there is evidence of WTC dust in the building, then this may be considered to provide support for the decision to clean the building. Separate analysis will be conducted for accessible and infrequently accessed areas and each area will be compared to its own benchmarks. An exceedance of the 95% UCL in either set of areas will be the basis for offering a building cleanup. Only data for units with evidence of WTC dust present will be used in calculating the UCL. However, it should be noted that source attribution will be a critical factor in determining whether to reclean after cleaning. For example if lead exceedances trigger the 95% UCL criteria as described here, a building cleanup will occur as with other COPC triggering the 95% UCL. However, a source survey will be conducted where exceedances are found and if it is found that the exceedance is due to a source within the building or adjacent to the building, no further cleaning or resampling to demonstrate clearance will be offered. Although most pertinent to lead, the same principle applies to the other COPC – if the exceedances resulting in the building cleanup can be attributed to a source within or adjacent to the building, no further cleaning or resampling to demonstrate clearance will be offered.

Decision for Phase II: Decisions will also need to be made once the sampling is completed relating to whether the data supports a more general sampling and/or cleanup program within a particular strata or an expansion into a Phase II program that extends beyond the borders of the current sampling effort. Decisions regarding expansion into a Phase II will include an examination and comparison of the data for the buildings in the sampled areas to each other and to plume modeling data from 9/11/2001. Expansion could be considered if there is ample evidence of both the presence of WTC dust as well as significant exceedances of the COPC benchmarks in areas outside of the area with confirmed or possible/probable contamination.

Decision for Additional Cleanup: Similarly, decisions as to whether a new general cleanup program is warranted within a stratum will be based on a careful examination of the data with particular attention to the spatial distribution of the WTC signature and COPC exceedances. Final decisions on these post-survey activities will be made by EPA with appropriate input.

(2) If validation of a screening method to identify a "signature" is not successful, the cleanup decisions will have to rely on the levels of contaminants of potential concern alone.

The absence of a WTC signature may make it very difficult to determine the geographic extent to which WTC dust has impacted indoor environments and whether any exceedances of COPC are related to the WTC collapse. In the absence of a measure that can identify WTC dust, EPA will offer a voluntary test, and clean if necessary, program targeted at the area south and west of Canal, Allen and Pike Streets, river to river. This is the area covered by EPA's WTC Residential Dust Cleanup Program. The "confirmed dust/debris" area identified by EPIC is contained within this boundary and conforms very closely to modeling performed to identify the area of maximum plume impact at the time of the collapse of the Tower 1, 2 and 7. Source attribution will be considered as described above.

The program offered will have two components. Services will be offered to both buildings and to individuals as described below:

Buildings

People living in the area in lower Manhattan described above who are concerned that dust from the collapse of the World Trade Center may still be present in their buildings may request assistance from EPA. Assistance offered includes the evaluation and cleanup (if necessary) of the individual residences, common areas and Heating, Ventilation and Air Conditioning systems (HVACs) of residential housing. Testing and cleanup work will be conducted by contractors and workers certified by New York State and New York City. Oversight will be provided by EPA personnel. Owners and managers of residential or commercial buildings can request to have their building's common areas and HVAC system evaluated and cleaned, if necessary. After receiving the request, and upon signature of appropriate access agreements, common areas and HVAC systems and/or other areas to which building management can provide access will be sampled as described above in section C, Approach to Building Characterization, with the exceptions noted below:

In the absence of a validated signature positive attribution of contamination to the WTC is impossible. Sampling will be conducted at the locations described above but they will not be analyzed for the signature. The COPC information gathered from the inaccessible areas and the HVAC system (if extant in the building) will only be used to identify potential reservoirs of contamination within the building. The benchmarks and evaluation procedure described above in section G. Decision Criteria for Activities Following Sampling, will be modified as follows.

A cleanup will be offered if the 95% UCL on the mean of any COPC exceeds the benchmark for that COPC in either accessible or infrequently accessed areas. However, in order to obtain more information about the potential role that HVACs have on air quality and the circulation of COPCs within buildings, whenever a decision to not offer a whole building cleanup is borderline and the HVAC contains elevated COPC levels, multiple air samples will be taken where HVAC outlets discharge into common areas of buildings (near the locations of the dust samples being taken as per the 3rd category of HVAC dust samples noted above). These air samples will be analyzed for concentrations of the COPCs asbestos, MMVF, PAH, and lead and the results compared to the benchmarks in the EPA COPC document. Any common areas with exceedances will be cleaned. The results will be evaluated with all other HVAC and full building results and source attribution surveys, to determine appropriate additional activities associated with HVAC sampling or cleanup. The full protocol for HVAC sampling is provided in the draft QAPP

Individual Residents

Individuals living in the area in lower Manhattan described above who are concerned that dust from the collapse of the World Trade Center may still be present in their residences may request assistance from EPA. Sampling will be conducted as described above for units in buildings. A cleanup will be offered if a benchmark for a COPC is exceeded in either accessible or infrequently accessed areas. EPA will conduct surveys to determine if the exceedance may be attributed to sources within or adjacent to the residence. If they are this information will be considered in conjunction with information on building cleaning history and the information gathered regarding COPC levels in potential reservoirs in the inaccessible areas and the HVAC (if extant in the building) to determine whether further cleaning or resampling to demonstrate clearance will be offered.

Employees and Employers

The Occupational Safety and Health Act of 1970 gives employees the right to file complaints about workplace safety and health hazards. If employees or their representatives believe that their working conditions are unsafe or unhealthful as a result of contamination by WTC dust they may follow the procedures outlined at :

http://www.osha.gov/as/opa/worker/complain.html

to file a complaint.

Alternatively, employees, authorized representatives of employees, or employers can request an evaluation by the National Institute of Occupational Safety and Health of possible health hazards associated with a job or workplace. The procedure to be followed is outlined at:

http://www.cdc.gov/niosh/hhe/Request.html

II. WTC SIGNATURE DUST SCREENING METHOD VALIDATION STUDY

A. Background: The objective of this effort is to develop and validate a means of determining whether dust sampled as part of EPA's planned sampling program contains residual contamination attributable to the destruction of the WTC towers. The sampling plan discusses the development of a "signature" capable of identifying "WTC dust." During the initial stages of signature development, it was believed that such a signature could include constituents associated with either the initial WTC towers collapse or the subsequent fires that burned until December 2001. The collapse dust signature work focused on inorganic compounds and fibers from building construction materials. The fire signature research focused on dust-borne polycyclic aromatic hydrocarbons (PAHs) that are well documented products of incomplete combustion.

Research investigating products of the WTC fires has shown that there is a statistical difference in internal composition and enrichment of PAHs between initial airborne and settled WTC dusts and background dusts. The "internal composition" refers to the ratio of specific congeners to each other. The presence of residues from combustion processes would result in a shift from a "background" PAH congener profile to a different profile associated with fires. This shift occurs with different forms of combustion, such as cigarette smoking or wood burning, and it is expected that this profile would also be found in general building fires, not just WTC fires. The "enrichment" refers to the fact that WTC fires produced a relatively large amount of PAHs, such that WTC dust had more mass of overall PAHs as compared to background dust. The WTC dusts which most clearly had this "fire signature" were dusts sampled near September 11, 2001. Contemporary samples of dust (taken late 2004, early 2005) from undisturbed locations in the heavily impacted Deutsche Bank building at 130 Liberty Street in 2005 were also "enriched" with PAHs, but showed a congener profile with characteristics leaning towards a background profile. The cause for the shift of contemporary samples towards a background profile is not known, but may be due to Deutsche Bank dust containing a meaningful amount of building collapse dust, possibly other urban dusts that entered the building over time, degradation/volatilization or other mechanism.

In summary, the fire signature research effort indicated: 1) that the WTC PAH congener profile, clearly found in air particulates as well as settled particulates in 2001, appears to also be characteristic of general combustion, including other building fires; and 2) that the WTC PAN congener profile found in 2001 samples was not found as clearly in samples collected during 2004/2005, even in locations such as the Deutsche Bank where it would most likely be found, if it existed at all in indoor contemporary settings. For these two reasons primarily, EPA has decided to focus its efforts primarily on a signature for the building collapse.

The suggestion that there is a distinctive profile of slag wool, gypsum and elements of concrete in WTC dusts from the initial collapse has also been investigated. In contrast to the PAH results, contemporary samples have shown that the slag wool concentrations remain strong in impacted locations such as the Deutsche Bank. Details are provided below.

This screening method is a critical component of the sampling program as it will be used, along with results from COPC testing, to determine the need for cleanups. Decision rules for units, buildings, expanding into a second phase of sampling and other possible activities were described in the section above. It is important to understand the implications of the method as a "screening method," in the context of this decision making. It cannot be expected that dust sampled today in the indoor environment has such unambiguous characteristics as the dust sampled near September 11, 2001, in impacted locations, and this was borne out by the PAH fire signature work described above. Because of this expectation, the signature validation study (described below) will seek to develop a method that identifies the key WTC components, but at levels that are only a fraction of the levels seen in more pure "WTC dust." Thus, the final levels used to "screen" for WTC dust will be much less than the levels seen shortly after September 11, 2001.

If the WTC building collapse signature components of slag wool, gypsum and elements of concrete are ***not present***, then it would be appropriate to conclude that ***WTC building collapse dust is not present***. However, since these components might be present in background NYC dust, as slag wool is a component of insulating materials in currently constructed buildings, it is possible that a test might show them to be present even though WTC dust never impacted the sampled area. A "screening test" will, by its design, result in some fraction of such "false positives." However, an appropriate "screening test" would result in very few, if any, "false negatives." Specifically, if a sample does not contain these WTC signature constituents, the conclusion would be that WTC dust is not present in the sampled area; it is expected that this will almost always be a true conclusion.

The following sections describe the derivation of this signature, the results of the "proof-of-concept" and method development work that was undertaken by EPA prior to the rigorous signature method validation study, and then an overview of the method validation study itself.

Scanning electron microscopy techniques are used to identify fibers that are then "counted." Unfortunately, there are not uniform means to then translate that count into a final result among different published methodologies. The methods that have been developed for this signature work express results in terms of fibers per gram of particle. Results discussed below include units in percent area, in ppm and percent by weight, and finally the EPA-derived results are expressed in fibers per gram of dust. Such lack of uniformity makes comparison between studies difficult, but as described below, the trends among the studies are consistent in identifying the key WTC dust signature constituents.

B. Derivation of the Signature: To be considered useful screening materials in this sampling program, WTC dust signature constituents must meet the following criteria:

1) they are present at levels unique to WTC dusts, distinct from urban dusts;
2) they are persistent for many months (not volatile);
3) they are homogeneous in WTC dust; and
4) available analytical methods are able to detect these screening materials with a small sample size, low minimum detection limit, and low interference from other dust components.

The USGS has published two reports which provide the basis for the WTC dust signature adopted in this sampling program, and which address three of these four critical criteria. The first report discusses the analysis and interpretation of indoor and outdoor WTC dust samples collected near Ground Zero, days and weeks after September 11, 2001 (Meeker, et al, 2005). Specifically, USGS analyzed six samples including 1) three outdoor samples collected by USGS on September 16 and 17 at distances of 0.8, 0.6, and 0.55 from the center of Ground Zero, 2) one indoor sample collected by USGS on the 30th floor of a building two blocks from Ground Zero, and 2) two samples collected by Lioy, et al. (2002), one outdoors at approximately 0.7 km from the WTC site collected as part of a sampling effort by Lioy occurring on September 16 and 17, 2001, and one indoors collected November 19, 2001 in a building adjacent to Ground Zero. Results from this effort are presented in units of percent area. Further details on the analysis procedures and other aspects of this study are provided in Meeker, et al. (2005). An overview of the results is provided in Table 5.

As seen in Table 5, the WTC dust samples are dominated by gypsum, concrete and man-made vitreous fibers (MMVF), mainly slag wool. All other components were marginal in comparison. It is on the basis of these key results that gypsum, elements of concrete and slag wool were identified as candidates for a WTC signature. They are not volatile and do not degrade – hence they meet the second criteria as identified above. It could be argued that they do not meet the third criteria, which is that they be homogenous between WTC dust samples. As seen in Table 5, for example, individual sample concentrations of gypsum varied between 26 and 53% in 4 outdoor samples. However, as a trio, the sum of these components comprised over 88% of all components in all six WTC samples. Therefore, as a group, one can conclude that the third criterion of homogeneity is met.

However, this analysis of WTC dust did not address the first criterion above – that the constituents are present at levels unique to WTC dust. In order to address this criterion, the EPA supplied the USGS with samples taken from several indoor locations well outside of the WTC impacted area. These samples were taken between September 2004 and April 2005. The USGS analyzed six of these samples. Three of the samples analyzed were taken above 75th St in Manhattan (two on the West side and one on the East side of Central Park), one was taken at 181st Street in Manhattan, and two were taken on Long Island over 6 km from Ground Zero. These samples represent vacuumed surfaces including carpets, bathroom vents and tops of storage units. The USGS focused on MMVF for these samples. Results for a variety of MMVF components are shown in Table 6. This table shows the count of fibers on the microscopic substrate, as well as the conversion into a mass concentration of the MMVF in dust, expressed both as percent and ppm. Further details of this analysis of background samples can be found in Lowers, et al. (2005).

As seen in Table 6, slag wool is absent from many of these samples. One of the MMVF components, soda-lime glass, is present in one sample, but this MMVF was not found in WTC dust samples. Although the results are not presented in the report, Lowers et al (2005) state that the samples do have gypsum present, which they speculate might be due to the presence of wall board in the sampled apartments. Because of the lack of slag wool in these samples, it was concluded that these samples did not contain WTC dust. It was also concluded from this examination of background samples that perhaps slag wool is the single most critical of the three WTC dust constituents that will be used to distinguish WTC dust from other New York City dusts. This analysis of background samples provided evidence for the first criterion above – that the WTC signature constituents are present at levels unique to WTC dust, and are not present in non-WTC dust.

These USGS studies were not the only ones which identified MMVFs and gypsum as predominant components of WTC dust. In a key study of air and settled dust quality in apartments in lower Manhattan, the Agency for Toxic Substances and Disease Registry and the New York City Department of Health and Mental Hygiene found significantly more MMVF and gypsum in lower Manhattan apartments as compared to comparison areas above 59th Street (NYCDOMH/ATSDR, 2002). Specifically, they found MMVF in 40 of 83 lower Manhattan indoor locations ranging from 2% to 35% of the dust content, and in 11 of 14 outdoor locations at levels ranging from 1% to 72%. Meanwhile, no MMVF was found in comparison locations. They also concluded that gypsum was seen at a higher percentage in dust in lower Manhattan samples as compared to the comparison area samples. Gypsum was seen in 88% of common areas and 79% of residences in lower Manhattan, and was found at a maximum concentration of 30% in settled dust in lower Manhattan as compared to a maximum of 4% in comparison areas. In a comprehensive study of the composition of settled dust in the Deutsche Bank building at 130 Liberty Street, R.J. Lee identified numerous hazardous contaminants that were present in the dust at levels much higher than in background office buildings, and among those substances identified in their "WTC signature" were mineral wool and gypsum (R.J. Lee, 2004).

C. Proof of Concept and Method Development: EPA took 71 samples during the time period of September 2004 to April 2005. A standard method using a HEPA vacuum collector was used by EPA to collect most bulk dust samples. Some bulk dust samples were collected from residential and commercial vacuum cleaner bags. These samples, along with two samples from the USGS, were analyzed by the EPA's National Exposure Research Laboratory (NERL) SEM laboratory using Scanning Electron Microscopy. They were analyzed for slag wool as part of the EPA's development of a standard protocol for sample preparation and analysis. They were not analyzed for elements of concrete or gypsum as an analysis method for these components had not yet been developed. For this method, results are expressed in terms of fibers per gram of dust particle, abbreviated f/g. It should be noted that, as the method was being developed during the analysis of these samples, the results should be interpreted as preliminary in nature.

EPA has characterized these samples as follows:

a) "Impacted" samples: Twenty-one samples were taken by the EPA at two buildings that were part of the Deutsche Bank complex, and were located at 130 Liberty Street and 4 Albany Street. Both buildings are currently uninhabited and slated for demolition. EPA has analyzed eight of these samples and they are shown in Table 7. Two additional samples taken by the USGS immediately following 9/11 (one composite outdoor samples and one individual outdoor samples) were also utilized by the EPA in this method development phase. The slag wool result from one of these two samples is noted below.

b) "Unimpacted" or "background" samples: EPA collected 50 samples from locations well beyond the study boundaries and at distances such that one can hypothesize that they would be unimpacted. EPA has analyzed 32 of these samples to this point, and the results are shown in Table 7.

As seen in Table 7, there appears to be a clear distinction between samples taken in "impacted" versus "background" samples. All of the impacted samples had slag wool at concentrations greater than 100,000 fibers of slag wool per gram of dust with a range of 113,000 to 11,800,000, while all of the unimpacted samples had concentrations less than 100,000 ppm, ranging from no slag wool identified in 10 samples to 92,800 fibers of slag wool per gram of dust.

It is possible that there was some dilution of the "impacted" samples within the buildings. One of the two USGS dust samples taken in September 2001 provided to EPA for this proof-of-concept method development phase was analyzed and it showed the highest concentration of all samples measured, at 13,400,000 f/g. While this is close to the highest currently collected sample of 11,800,000 f/g, all other samples were under 6,000,000 f/g with 4 of 8 under 1,000,000 f/g.

D. Method Validation Study: The USGS, the EPA's Office of Research and Development, the EPA's National Enforcement Investigations Center (NEIC), and a number of experts from the commercial testing laboratory community, worked together to develop an analytical method to identify the presence and quantify the concentration of the screening constituents in indoor dust, including slag wool, gypsum and elements of concrete. This method was reviewed by the WTC Panel's Signature Subgroup. The primary purpose of this method validation study is to verify that this overall analytical method produces consistent results when applied by different laboratories, and that it can analyze for the three constituents at reasonable cost and timeframe. This addresses the final criteria above, "available analytical methods are able to detect these screening materials with a small sample size, low minimum detection limit, and low interference from other dust components."

The working hypothesis for the WTC dust screening method is as follows: "A dust sample that contains WTC dust will have slag wool, and elements of concrete and gypsum present in 'significant quantities' when compared to typical indoor urban dust." In addition to validating the method using multiple laboratories, defining "significant quantities" is the second major purpose of the validation study. As noted, it is not expected that indoor dust will have exactly the same characteristics of the originally sampled outdoor dust collected by USGS in September 2001, and this expectation was verified with the slag wool results derived during the proof-of-concept phase described above. Mixtures of WTC dust and background dust at various dilutions of WTC dust will help define how much of these constituents will constitute a 'significant quantity.'

Five independent laboratories have been recruited for this final method validation phase. Each laboratory has attended a two day session during which the method was further developed and discussed, and procedures to adapt the method to suit each laboratory's equipment were determined. Following this session, the laboratories received dust samples consisting of both confirmed background samples and background samples spiked with varying amounts of WTC dust. The spiked dust contains known quantities (concentrations) of the screening materials. The labs were provided the samples "blind," thus they do not know which samples are pure background dust and which are the background dust samples spiked with WTC dust. The labs will have several weeks to analyze all dust samples. They were asked to provide data as to the quantity of screening materials present in the dust, and to determine whether that dust meets the criteria for identifying WTC dust as defined by the hypothesis above. The final data from all laboratories will be evaluated to determine if they were able to distinguish background samples from WTC spiked samples. In effect, the data will be evaluated to determine whether a validated marker of WTC collapse residue is present, and the lowest concentration of WTC residue that should be present in the dust for the protocol to work.

The goal is to validate a method of differentiating between samples of dust that contain residues from the WTC collapse from those that do not. However, since the three primary materials (slag wool, and elements of concrete and gypsum) identified above are all normally found in dusts present in the New York area, it is possible that the proposed screen may yield some percentage of false positive identifications of WTC dust. As discussed above, a "screening method," by definition, will result in some fraction of false positives. As long as the false positive rate is not too large, and very few, if any, false negatives are found, the method will be considered reasonable for use.

The WTC signature dust screening method validation study report will be subjected to an independent external peer review by experts in this field.

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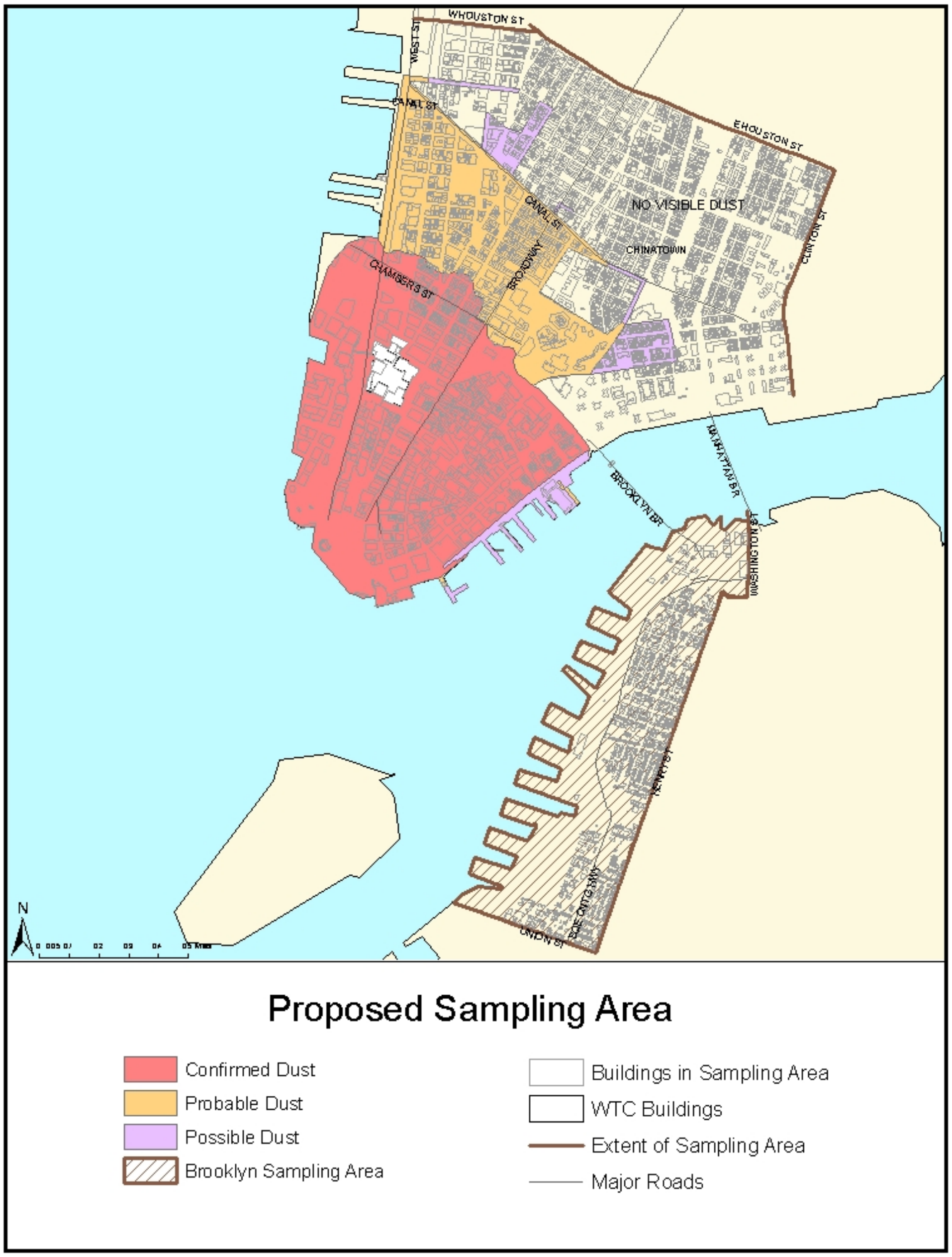

Figure 1. The study area of lower Manhattan bounded by Houston Street, overlain on the EPIC results which are displayed in three colors: red meaning confirmed dust/debris; orange meaning probably dust/debris, and pink meaning possible dust/debris.

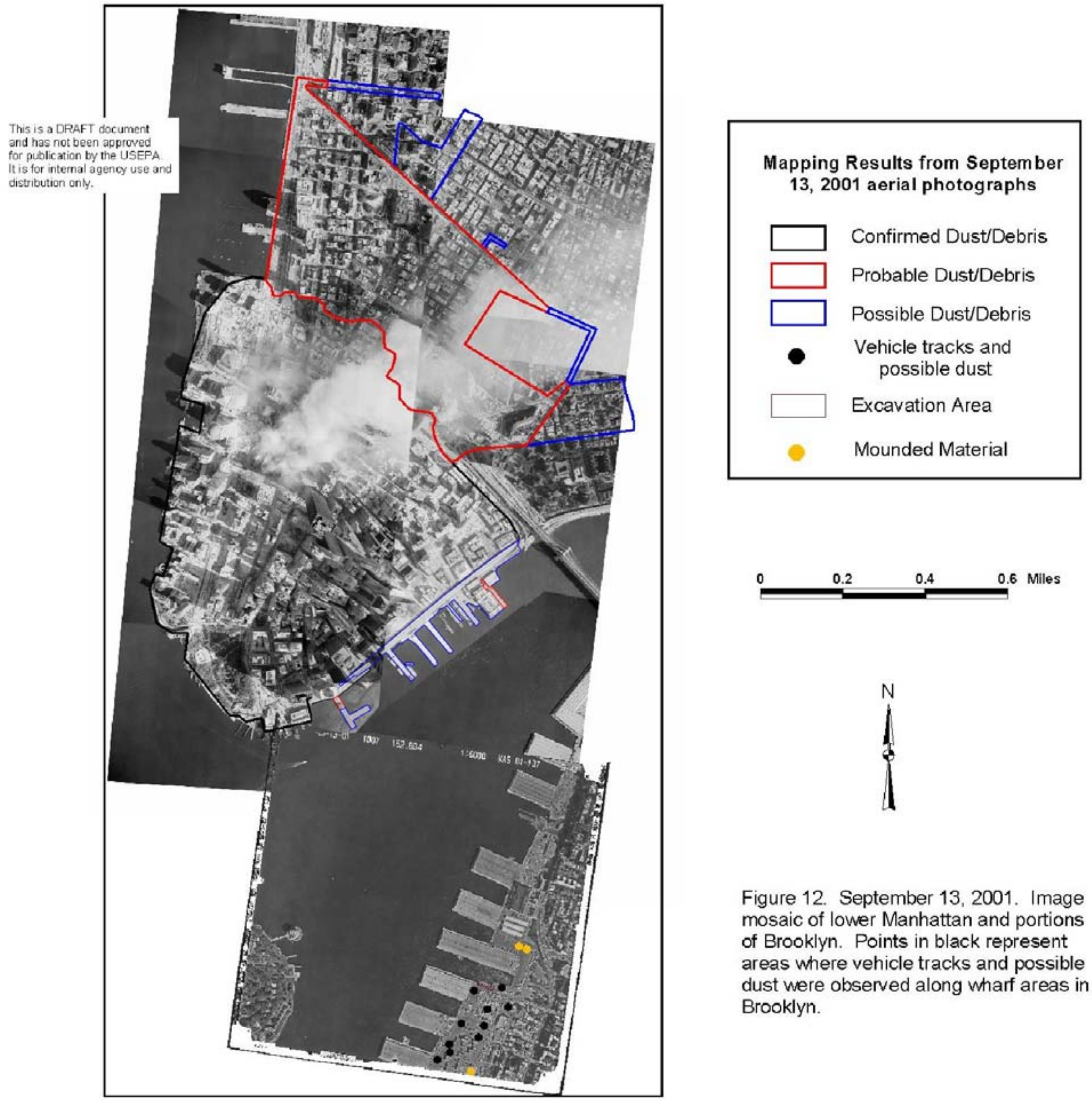

Figure 2. Display of boundaries of expected deposition based on analysis conducted by EPA's Environmental Photographic Interpretation Center (EPIC; this figure is updated by EPIC from the figure which appears in EPIC, 2004).

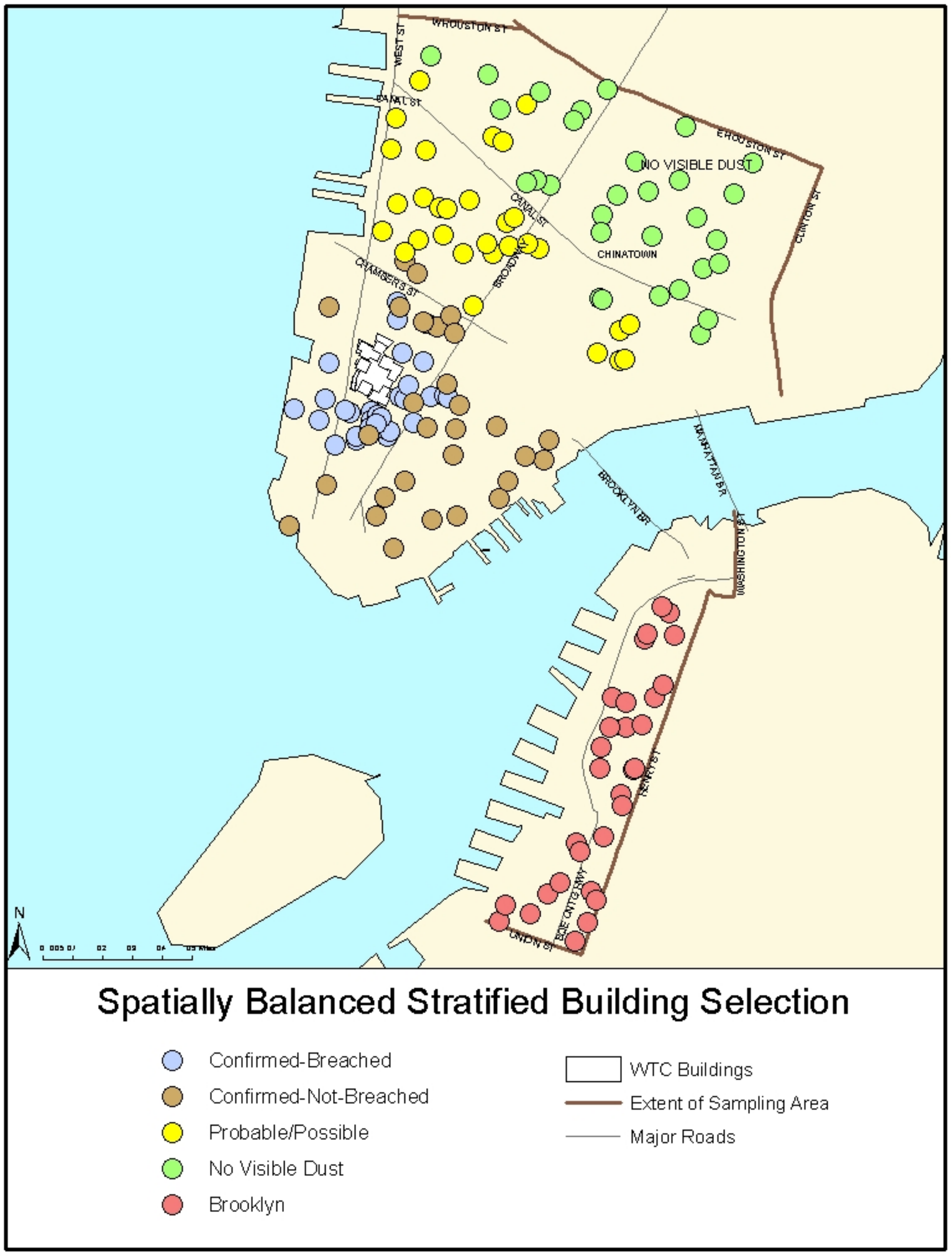

Figure 3. Example of possible outcome of a spatially balanced approach to building selection .

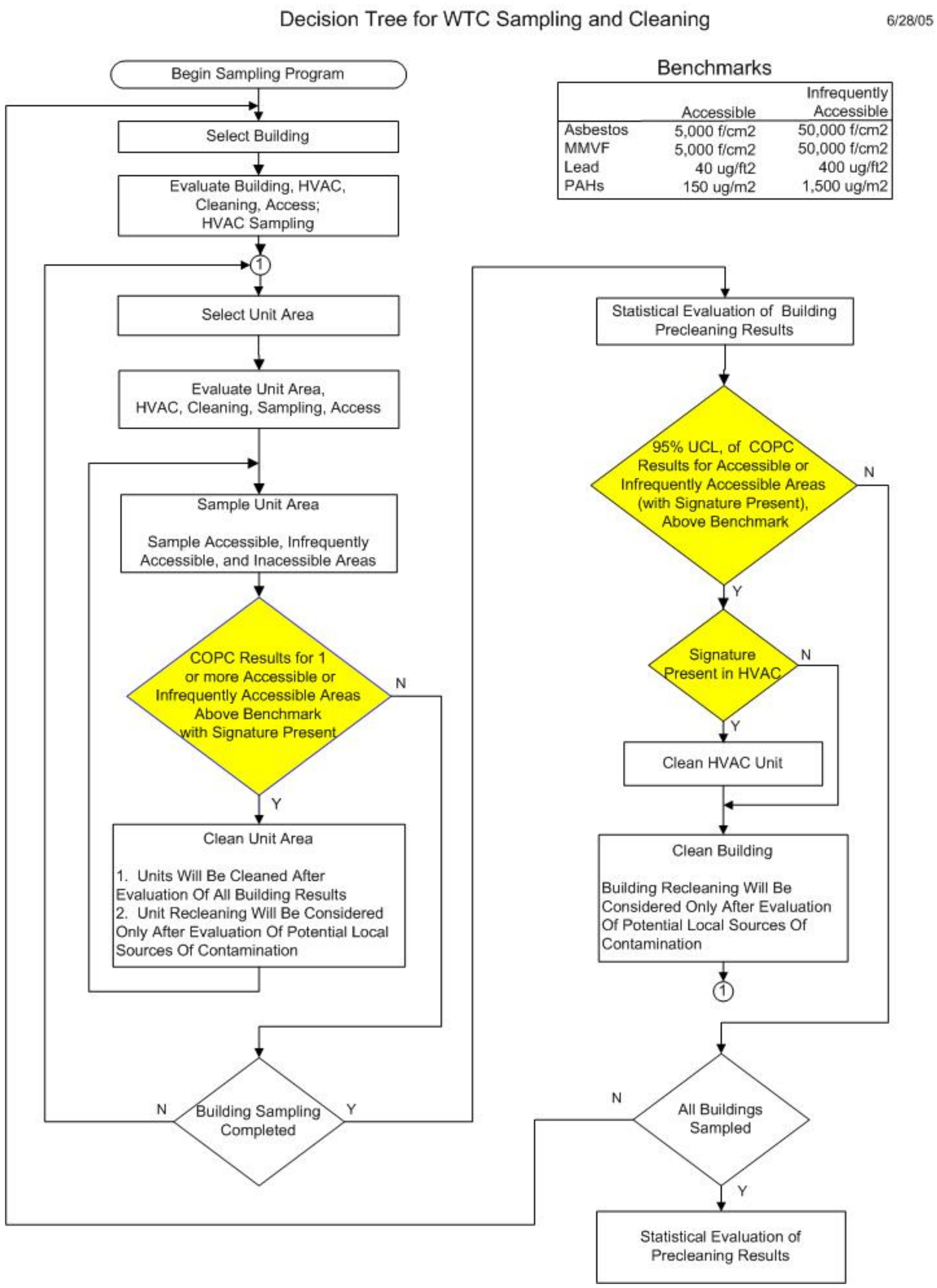

Figure 4. Decision tree for WTC sampling and cleaning.

Table 1. Summary Statistics for Buildings in Zones

DUST ZONE	NBR_BLDGS	FLOORS				Year BUILT			
		NBR BLDGS with DATA	RANGE			NBR BLDGS with DATA	RANGE		
			Min	Max	Average		Min	Max	Average
CONFIRMED-BREACHED	53	48	2	58	17	45	1900	1993	1941
CONFIRMED-UNBREACHED	801	702	1	63	10	636	1857	2003	1928
POSSIBLE	946	894	1	53	6	772	1860	2003	1919
NO DUST	3269	3079	1	44	5	2214	1800	2003	1913
BROOKLYN	1313	1296	1	29	4	1122	1800	2003	1902

Table 2. Building Database Description (source, NYC Department of Housing Preservation)

Seq #	Table, Function or Store Pro. Name	Column Name	Data field	Position		Comments
1	BLDG	BLDG_ID	NUMBER(10)	001	010	A unique number assigned by HPD to each building for identification.
2	BLDG	PIN	NUMBER(10)	012	021	Premises identification number. This number is an internally used HPD reference.
3	BLDG	BIN	NUMBER(9)	023	031	Internal ID used by Department of Buildings.
4	DDW_BORO	BORO	CHAR(1)	033	033	Each borough is assigned a number. 1-Manhattan, 2-The Bronx, 3-Brooklyn,4-Queens and 5-Staten Island.
5	BLDG	BLK	CHAR(5)	035	039	An individual area of land which is usually enclosed by city streets. Each block is assigned a unique identification number by the Department of Finance.
6	BLDG	LOT	CHAR(4)	041	044	An individual parcel or a plot of land. Each lot is assigned a unique identification number by the Department of Finance.
7	BLDG	COMU_DIST(CD)	NUMBER(3)	046	048	A unique number assigned to each Community District.
8	BLDG	CNSUS_TRCT	CHAR(6)	050	055	A relatively permanent statistical subdivision of a county in a metropolitan area, delineated by a committee of census data users for the purpose of presenting decennial census data. Census tract boundaries normally follow visible features, but may follow governmental unit boundaries.
9	BLDG	PHN	CHAR(12)	057	068	Primary House Number - Street number where the building is located.
10	BLDG	STR_NM	CHAR(32)	070	101	Street number where the building is located.
11	BLDG	RANGE	CHAR(25)	103	127	Range of addresses (lowest street number – highest street number) by which the property is known. Concatenate Function (low hus_no||','||High_us_no)
12	BLDG	ZIP	CHAR(9)	129	137	Zip Code
13	BLDG	MDR_NO	NUMBER(10)	139	148	Multiple Dwelling Registration Number - A unique number assigned by HPD to individual apartment buildings.
14	BLDG	LEGL_CLAS_A_APTS	NUMBER(6)	150	155	"A" units are dwellings used, as a rule, for permanent residences. The typical residential apartment is an "A" unit.

15	BLDG	LEGL_CLAS_B_APTS	NUMBER(6)	157	162	"B" units are dwellings used, as a rule, on a temporary basis.
16	BLDG	LEGL_STRYS	NUMBER(3)	164	166	The number of stories or floors in the building.
17	DDW_BLDG_ CLAS	BLDG_CLAS	CHAR(50)	168	217	HPD's internal building classification. The following are the codes and their definitions.

A	OLD LAW TENEMENT
B	NEW LAW TENEMENT
C	OLD LAW SINGLE ROOM OCCUPANCY
D	NEW LAW SINGLE ROOM OCCUPANCY
E	HEREAFTER ERECTED CLASS A
F	HERETOFORE ERECTED EXISTING CLASS A
G	HERETOFORE CONVERTED CLASS A
H	HEREAFTER CONVERTED CLASS A
I	JOINT RESIDENTIAL/ARTISTS
J	CONVERTED OLD LAW TENEMENT
K	CONVERTED NEW LAW TENEMENT
L	LODGING HOME
M	Y-TYPE BUILDING
N	HEREAFTER ERECTED CLASS B
O	HERETOFORE ERECTED EXISTING CLASS B
P	HERETOFORE CONVERTED CLASS B
Q	HEREAFTER CONVERTED CLASS B
R	COMMERCIAL ALTERED CLASS B
T	TEMPORARY CERTIFICATE OF OCCUPANCY
W	COMMERCIAL ALTERED CLASS A
Y	CONVERTED DWELLING
7	INTERIM MULTIPLE DWELLING
X	PD GARDEN/MASONETTE
9	1 FAMILY HOUSE

						N/A NOT AVAILABLE 8 2 FAMILY HOUSE
18	PROG	PROG_SHRT_NM	CHAR(15)	219	233	Management Program Indicates if the property is privately owned(PVT) or publicly owned.
19	BLDGLOAD_DT1 OR BLDGLOAD_DT2	LAST_INSP_DT	CHAR(8)	235	242	(2) FUNCTION, Last Inspection date
20	BLDGLOAD_ERP	ERP_REPAIR_IND	CHAR(1)	244	244	FUNCTION, Emergency Repair Program Indicator
21	BLDGLOAD_DT3	LAST_ERP_DATE	CHAR(8)	246	253	FUNCTION, Date of last Emergency Repair Program
22	STR_CODE	STR_CODE	CHAR(5)	255	259	Street Code
23	BLDG	YR_BUILT	CHAR(4)	261	264	Year Built
24	BLDG	DOF_BLDG_CLASS	CHAR(2)	266	267	Department of Finance Building Classification Code (see table)
25	DOF_BLDG_CLASS	DOF_BLDG_CLAS_DESC	CHAR(60)	269	328	Department of Finance Building Classification Description
		TOTAL	**304**	**328**		

Table 3. Building Database Description – Building Classifications

DOF_BLDG_CLASS	DOF_BLDG_CLAS_DESC
A1	One Family House/Two Story Detached
A2	One Family House/One Story
A3	One Fam House/Large suburb Res
A4	One Fam House/City Residence
A5	One Fam/Attach or Semi-Detached
A7	One Family/Mansion or Town House
A9	One Family/Miscellaneous
B1	Two Family/Brick
B2	Two Family/Frame
B3	Two Fam/Convert from One Family
B9	Two Family/Miscellaneous
C0	Walk-Up Apts/Three Families
C1	Over Six Families w/o Stores
C2	Walk-Up Apts/3 to 6 Families
C3	Walk-Up Apts/Over 6 Families
C4	Walk-Up Apts/Old Law Tenements
C5	Converted Dwelling/Rooming House
C6	Walk-Up Apt/Cooperatives
C7	Walk-Up Over 6 Fam w/Stores
C8	Co-Op Convert from Loft/Wareho
C9	Walk-Up Apt/Miscellaneous
D0	Elevator Apartments
D1	Elev Apts/Semi-Frprof W/0 Store
D2	Elev Apts/Semi-Frprof W/0 Store
D3	Elevator Apts/Frprof W/0 Store
D4	Elevator Apt/Co-ops(no Condos)
D5	Elevator Apts/Converted
D6	Elev Apts/Fireproof(w/Stores)
D7	Elev Apts/Semi-Frprof w/Stores
D8	Elevator Apts/Luxury Type
D9	Elevator Apts Miscellaneous
E1	Warehouses/Fireproof
E3	Warehouses/Semi-Fireproof
E4	Warehouses/Frames
E9	Warehouses/Miscellaneous
F1	Heavy Manufacturing(fireproof)
F2	Factory/Industry/Spec. Construction
F4	Factory/Industry/Semi-Fireproof
F5	Fact/Indust/Light Manufacturing
F8	Factory/Industry Tank Farms
F9	Factory/Industry Miscellaneous

G0	Garage and Gasoline Stations
G1	Garage - Two or More Stories
G2	Garage/One Story
G3	Garage and Gas Station Combine
G4	Gas Sta w/Enc Lube Plant/Wkshop
G5	Gas Sta wo/Enc Lube Plant/Wkshop
G6	Licensed Parking Lot
G7	One or Two Car Garage
G8	Garage with Showroom
G9	Miscellaneous
H1	Hotel/Lux Type Prior to 1960
H2	Hotel/Lux Type Built After 1960
H3	Hotel/Transient Occu Mdtown Ma
H4	Hotel/Motels
H5	Hotels/Private Club
H6	Hotels/Apartments Hotels
H7	Hotels/Apartments Hotels Co-op Owned
H8	Hotels/Dormitories
H9	Hotels/Miscellaneous
I1	Hosp
I2	Hospitals & Health/Infirmary
I3	Hospitals and Health/Dispensary
I4	Hospitals & Hlth/Staff Facilities
I5	Hlth Centr
I6	Hospitals & Health/Nursing Home
I7	Hospitals/N.A.
I9	Hospitals & Hlth/Miscellaneous
J1	Theatr/Art Type under 400 Seats
J2	Theater/Art Type over 400 Seats
J3	Motion Picture Theatrew/Balcony
J4	Legitimate Theatres
J5	Theatr part of Bldg of other Use
J6	Theaters/T.V. Studios
J7	Theaters/Off Broadway Type
J8	Multi-Motion Picture Theatre
J9	Theaters/Miscellaneous
K1	One Story Store Building
K2	Two Story or Store and Office
K3	Department Stores
K4	Stores/With Apartments Above
K5	Diners
K7	Funeral Home
K9	Store Bldgs/Miscellaneous
L1	Loft Bldgs/over 8 Stories
L2	Lofts/Fireproof & Storage Type

L3	Loft Bldgs/Semi-Fireproof
L8	Loft Bldgs/with Retail Stores
L9	Loft Bldgs/Miscellaneous
M1	Church
M2	Mission House (Non-Residental)
M3	Paronage
M4	Convents
M9	Churches Synagogues/Misc.
N1	Asylums
N2	Home/Indigent Kidgs
N4	Detention Houses Wayward Girls
N9	Asylums and Homes/Misc
O1	Office Big/Fireproof to 9 Stores
O2	Office Big/10 Fls & Over/Side St
O3	Office 10 Fls & Over/Main Av
O4	Office Bldg/Tower Type
O5	Office Bldg/Semi-Fireproof
O6	Bank Bldg Exclusively for Bank
O7	Professioal Office Building
O8	Office Bldg/with Res Apts
O9	Office Bldgs/Misc.
P1	Concert Halls
P2	Lodge Rooms
P3	YWCA
P4	PAL
P5	Community Center
P6	Amusement Place
P7	Museum
P8	Library
P9	Misc
Q1	Parks
Q2	Playgrounds
Q3	Outdoor Pools
Q4	Beaches
Q6	Stadium
Q7	Tennis Courts
Q9	Recreation Facilities/Misc
R0	Condominiums
R1	Condos/One Family(Attached)
R2	Condos/Walk-up Apartments
R3	Condos/ 1-3 Story Condo
R4	Condos/Apt Building W/Elev
R5	Condos/Commercial Bldgs
R6	Condos/Apt/N.A.
R8	Condos/Apt/N.A.

R9	Condos/Miscellaneous
S0	Residential Multi Use
S1	Multi Use/1 Fam w/Store or Ofc
S2	Multi Use 2 Fam w/Store or Ofc
S3	Prime 3 Fam w/Store
S4	Prime 4 Fam w/Store
S5	Prime 5-6 Fam w/Store
S9	Prime Fam/N.A.
T1	Airport
T2	Piers
T9	Transportation Facilities/Misc.
U1	Bridges
U2	Electric Utilities
U4	Telephone Utilities
U6	Railroads
U7	Transportation
U8	Revocable Consents
U9	Utility Bureau Props/Misc.
V0	Vacant Land
V1	Vacant Land
V2	Vacant Land/Police Dept
V3	Vacant Land/Hospital
V4	Vacant Land/Fire Dept
V5	Vacant Land/School Site or Yar
V6	Vacant Land/Library or Museums
V7	Vacant Land/Port Authority
V8	Vacant Land/State & Feds
V9	Vacant Land/Misc.
W1	Public Elementary Jr & Sr HS
W2	Parachial Schools
W3	Schools or Academies
W4	Training Schools
W5	City University
W6	Other Colleges and Universities
W7	Theological Seminaries
W8	Other Private Schools
W9	Education Structures/Misc
Y1	Gov't Installations/Fire Dept
Y2	Gov't Installations/Police Dept
Y3	Gov't Instal/Prisons
Y4	Gov't Instal/Military and Naval
Y5	Gov Instal/Dept of Real Estate
Y6	Gov't Installation/Dept of Sanitation
Y7	Dept of Marine & Aviation
Y8	Dept of Public Works

Y9	Dept of Gas
Z1	Court House
Z2	Public Speaking Areas
Z3	Post Office
Z4	Foreign Governments
Z5	United Nations
Z6	Land Under Water
Z7	Easements
Z8	Cemeteries
Z9	Other

Table 4. Proposed sampling and analytical methods for the building sampling program.

Type of Location	Locations	Samples to be collected	Number of Locations
Accessible areas are defined as areas in which exposures of residents or office workers readily occur	i) area or wall-to-wall carpeting. locations include, in an order of most to least preferred location (on the basis of exposure considerations): 1) in the main entrance used for access and egress from the building; 2) carpet in the secondary, less heavily used entrance to the unit; 3) carpet in the center of the most frequently used play area for children under the age of six; and 4) carpet in an acknowledged or evident route of high traffic flow (i.e., stairs, hallway, etc.); ii) kitchen tiled floor, hardwood floors, or hard floors of other surfaces types (laminate, e.g.); iii) draperies/curtains in the living room, which is the primary location if unit is a residence, and then draperies/curtains in other rooms of the unit; iv) the wall at hand level for a resident child or adult where there are no children; v) the wall adjacent to the head of the bed in a child's bedroom, or in the adult bedroom where no children occupy the unit; vi) kitchen counter tops; vii) table or desk tops viii) upholstered furniture.	1 microvac, 1 PAH wipe, 1 Metal Wipe at each location sampled	scaled to floor area as follows: <1000sf = 3 locations, >1000 <5000sf =5locations, >5000sf =7 locations, >10000sf =10 locations
Infrequently Accessed areas are defined as areas in which dust may accumulate but cause infrequent exposure of residents or workers	i) the trough of a window sill; ii) the top of vent ducts, or hot water pipes; iii) on top, beneath or behind large appliances or objects of furniture such as beds, chests, refrigerators, upright freezers, built in file cabinets or bookcases;	1 microvac, 1 PAH wipe, 1 Metal Wipe at each location sampled	scaled to floor area as follows: <1000sf = 3 locations, >1000 <5000sf =5locations, >5000sf =7 locations, >10000sf = 10 locations

Inaccessible areas are defined as areas in which dust may accumulate but which rarely cause exposure to residents or office workers	i) behind rarely moved objects such as wall units and heavy appliances such as,dishwashers and stoves; ii) behind or underneath rarely moved objects of furniture such as large chests; iii) in corners of closets or similar small areas rarely accessed or cleaned; iv) above suspended ceilings.	1 composite HEPA of all locations sampled	scaled to floor area as follows: <1000sf = 3 locations, >1000 <5000sf =5 locations, >5000sf =7 locations, >10000sf only one composite regardless of area
HVAC	Inlets that are facing Ground Zero are preferred. Samples will not be taken in an outdoor air inlet where an extraordinary effort is required, such as when the air inlet is located in a location that would require scaffolding or hoists for access;	1 composite HEPA of all inlets sampled	assume 1 per bldg
	Filter	1 Bulk Sample	assume 1 per bldg
	Sample of ducting, air mixing plenums or other spaces serving sampled floors. The location should be accessible and should be in a central location between sampled units. If possible, samplers should seek out locations near outlets that are also near bends and turns within the plenum.	1 composite HEPA of all locations sampled	assume 1 per bldg
	All HVAC outlets in units discharging to locations where wipe or microvac (for measurement of COPCs) samples are taken.	1 composite HEPA of all locations sampled	assume 1 per bldg
Common Spaces Ambient Sampling	Ambient air sample sets for asbestos, MMVF, PAH and Lead in common areas on floors where unit samples have been collected	Set = minimum of three each asbestos/MMVF, PAH and Lead in each common space sampled	assume 5 sets of samples per bldg, scaled as follows: small spaces, less than 160 square feet, 3 samples sets will be collected, spaces greater than 160 square feet and less than 25,000 square feet 5 samples will be collected, spaces greater than 25,000 square feet, 1 sample will be collected for each 5,000 square feet.

II. Analytical Parameters for Each Sample					
Sample	**Analytical Parameters**	**Sampling Method**	**Description**	**Analytical Method**	**Benchmarks**
Metal Wipe	Lead	HUD Appendix 13.1	Wipe Samples.	SW-846 6010C	Accessible loading 40 µg/ft^2 Infrequently Accessed loading 400µg/ft^2
PAH Wipe	PAHs	ASTM D 6661-01	Wipe Samples.	SW-846 8270D	Accessible loading 150 µg/m^2 Infrequently Accessed loading 1.5 mg/m^2
Microvac	Asbestos	ASTM D 5755-95	Microvac sample	TEM SAED EDS	Accessible loading 5000 structures/cm^2, Infrequently Accessed/HVAC 100000 structures/cm^2
	MMVF	ASTM D 5755-95	Microvac sample	TEM SAED EDS Confirm with SEM EDS if benchmark exceeded	Accessible loading 5000 structures/cm^2, Infrequently Accessed/HVAC 100000 structures/cm^2
HEPA and Bulk Samples	Asbestos/MMVF	Bulk	HEPA and HVAC unit filters (collection of bulk dust sample from inaccessible areas, inlets,air filters,mixing plenums and outlets).	PLM NYS 198.1 followed by TEM NYS 198.4	None
	Lead	Bulk	HEPA and HVAC unit filters (collection of bulk dust sample from inaccessible areas, inlets,air filters,mixing plenums and outlets).	SW-846 6010C	None
	PAHs	Bulk	HEPA and HVAC unit filters (collection of bulk dust sample from inaccessible areas, inlets,air filters,mixing plenums and outlets).	SW-846 8270D	None
	Signature	Bulk	HEPA and HVAC unit filters (collection of bulk dust sample from inaccessible areas, inlets,air filters,mixing plenums and outlets).	SEM-EDS	None
Common Area Ambient	Asbestos/ MMVF	NIOSH 7402 3600 l sample		TEM SAED EDS confirm with SEM-EDS if MMVF benchmark is exceeded	.0009 f/cc .01 f/cc

	Lead	NIOSH 7300 3600 l sample		ICP-AES or MS	.7ug/m3
	PAH	NIOSH 5506 3600 l sample		HPLC	.2 ug/m3

Table 5. Results of USGS analysis of six World Trade Center dust samples.

Particle Type	**Comment**	**Percent Range, Outdoor , n = 4**	**Percent Range, Indoor, n = 2**
Gypsum	Includes all Ca sulfate particles	26.3 – 53.3	63.3 – 63.7
Concrete	All phases compatible with hydrated cement	19.3 – 30.8	14.0 – 21.0
MMVF Total		20.3 – 40.6	9.5 – 19.2
Slag wool	Based on table 2, field 2	91.7 – 98.1	89.5 – 93.3
Rock wool	Based on table 2, field 2	0 – 6.6	5.2 – 5.8
Soda-lime glass	Based on table 2, field 2	0 – 6.0	0.9 – 5.3
Chrysotile	Bundles and single fibers	0.4 – 1.8	0 – 0.1
Silica	Primarily crystalline	0.8 – 3.4	0.4 – 0.7
Ti-rich	Primarily Ti and Ti oxide	0 – 0.1	0 – 0.6
Zn-rich	Primarily Zn and Zn oxide	0.2 – 0.4	0.1 – 0.6
Pb-rich	Primarily Pb and Pb oxide	N.D.	0 – 0.03
Fe-rich	Primarily Fe and Fe oxide	0.2 – 1.3	0.1 – 1.1
Other	Identified but not binned	2.6 – 5.9	1.4 – 2.6
Unidentified	Could not be classified based on bulk chemistry	0.2 – 1.4	0 – 0.1

From Meeker, et al (2005)

Table 6. Summary results of MMVF in background samples analyzed by USGS.

Sample	**1**	**2**	**3**	**4**	**5**	**6**
# of Soda-Lime Fibers Observed	2	n.d.	3	58	2	3
# of Slag Wool Fibers Observed	n.d.	1	1	6	n.d.	1
# of Rock Wool Fibers Observed	n.d.	n.d.	n.d.	1	n.d.	2
# of other MMVF Fibers Observed	n.d.	n.d.	39	2	n.d.	0
% Slag Wool in sample	---	2.85E-05	2.39E-04	5.56E-03	---	4.02E-04
ppm (wt.)	---	0.3	2.4	56	---	4.0

From Lowers et al. (2005)

Table 7. Slag wool results from EPA's "Proof-of-Concept" method development efforts .

Impacted Site fibers per gram of particle, f/g	Background Sites fibers per gram of particle, f/g			
11,800,000	92,800	28,000	13,300	0
5,700,000	90,000	25,300	12,700	0
4,710,000	89,600	22,600	10,200	0
1,670,000	54,700	19,500	6,430	0
779,000	50,000	17,900	5,370	0
279,000	47,700	17,700	2,420	0
230,000	29,000	16,500	0	0
113,000	28,700	16,300	0	0